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CURRENT LITERATURE

BOOK REVIEWS

Ascent of sap

DIXON'S[1] volume on transpiration and ascent of sap clearly puts the evidence in favor of the cohesion theory, along with the weak points of the other theories. The chapter headings give an idea of the organization and contents of the work: (1) nature of transpiration and the ascent of sap; (2) ascent of sap in stems; criticism of physical theories; (3) ascent of sap in stems; criticism of vital theories; (4) cohesion theory of ascent of sap in stems; (5) tensile strength of the sap of trees; (6) estimate of the tension required to raise the sap; (7) osmotic pressure of leaf cells; (8) the thermo-electric method of cryoscopy; (9) method of extracting sap for cryoscopic observations; (10) osmotic pressure in plants; (11) energy available for raising the sap.

The cohesion theory of the rise of sap assumes that the water is drawn up through the stem by a pull applied at the top of the water column, and that this pull is transmitted downward through the cohering water. The pull, at least in high transpiration, is due to the evaporating power of the air, but it is limited in amount, as experiments indicate, by the osmotic pressure of leaf cells. The theory excludes living cells along the tracheary system of the stem and root from an active part in the rise of sap. At times of low transpiration, DIXON believes the living cells of the leaf blade may generate the pull by secreting water into the intercellular spaces. For the support of this theory three things require quantitative study: cohesion of sap under conditions existing in the tracheae; osmotic pressure of leaf cells; and total pull required to maintain the water column and to satisfy the transpiration loss in the highest trees at maximum transpiration. It is scarcely less important to know whether there is at all times a continuous water column in the stem of sufficient cross-section to account for the rise by cohesion, and whether actual tensions of considerable magnitude exist in this column. DIXON has apparently answered the first three points adequately, and has brought some evidence for the fourth; while RENNER has shown the existence of tensions of 10–20 atmospheres in the water of the stem tracheae of transpiring plants.

DIXON'S new measurements of the tensile strength of the sap of trees as exhibited in capillary tubes are of great interest. The values range from 45 to 207 atmospheres. The latter, according to DIXON, is the highest experimental value ever obtained for the cohesion of a liquid. The measurements were made with sap containing considerable air in solution, thus approximating the conditions in the tracheae. It is estimated that in the highest trees at maximum transpiration, the cohesion necessary to raise the sap does not exceed 20 atmospheres, a value well within the tensile strength of sap. For determining the osmotic pressure of leaf cells, DIXON has used the freezing point method. To this end, he and ATKINS have improved the current methods of extracting plant saps and have developed a thermo-electric method of determining the lowering of the freezing point. The essential new feature in the extraction of sap is the emersion of the tissue for some time in liquid air. This destroys all living semipermeable membranes and allows the solutes to be pressed out unrestrictedly with the water. The main advantage claimed for the thermo-electric method is the small amount of fluid needed, 2 cc. as against the 15–20 cc. for the ordinary Beckman apparatus. This is frequently a very important consideration for the plant physiologist. With the use of multiple juncture couples, a lowering of the freezing point by 0.0001° C. can be measured as against 0.001° C. for the Beckman. With the single juncture couples, used in the main by DIXON, a lowering of 0.01° C. can be measured. By reducing the size of the Beckman apparatus, BURIAN and DRUCKER were able to measure the lowering of the freezing point of 1.5–2 cc. of solution accurately to 0.005° C., and DRUCKER and SCHREINER by a different method were able to measure the freezing point of 0.005 cc. of a solution accurately to 0.01° C.[2] For the needs of the plant physiologist, I am inclined to think that the latter methods are more suitable.

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[1] DIXON, H. H., Transpiration and ascent of sap in plants. 8vo. viii+216. *figs. 30.* London and New York: Macmillan. 1914.

This book is rather more a statement of the extensive and in the main extremely important work of the author on the rise of sap than a critical consideration of the whole literature of the subject. This accounts for chap. vii, which presents DIXON'S cumbersome and inaccurate method of determining osmotic pressure of cells of the leaf by balancing it against gas pressure; for the slight consideration given RENNER'S work, which proves a critical point for the cohesion theory, namely the actual existence under certain conditions of a stretch of 10–20 atmospheres in the water of the tracheae; for the failure to point out that by a very different method RENNER confirmed a law established by DIXON, namely the rate of flow of a water column through a stem is proportional to the push or pull applied to it; and for the absence of the significant data of HANNIG, FITTING, and others on the osmotic pressure of leaf cells.

As yet the existence of a continuous gas-free water column from root to leaf under all conditions has not been established. Until this is established, there will be a just argument against the cohesion theory of the rise of sap.—WM. CROCKER.

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[2] HÖBER, Physikalischechemie d. Zelle, etc., p. 22. 1914; Biol. Centralbl. **33**:99. 1913.